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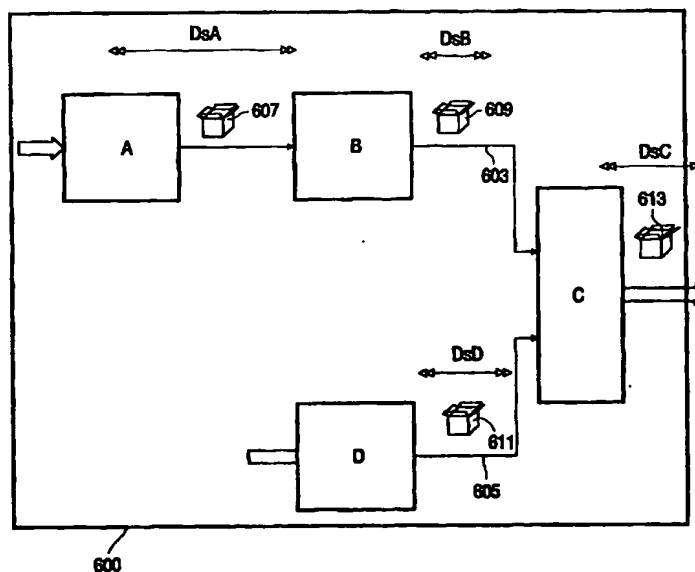
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(54) Title: PULL SCHEDULING OF SOFTWARE COMPONENTS IN HARD REAL-TIME SYSTEMS



(57) Abstract: The present invention relates to a method of determining when a component is schedulable in a hard real time system for processing time dependent streams of data elements. The number of components is larger than the number of available processors for processing said components, and each of the components have at least one input and at least one output. The components are scheduled by determining the earliest time on which a component can contribute to the output of the system and by scheduling the component that can contribute to the output at the earliest time. The invention also relates to a hard real time system for processing time dependent streams of data elements with means for performing the above scheduling.

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/EP 03/04938

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G06F9/48

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, INSPEC

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>HERRTWICH R G ED - INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS: "Time capsules: an abstraction for access to continuous-media data" PROCEEDINGS OF THE REAL TIME SYSTEMS SYMPOSIUM. LAKE BUENA VISTA, DEC. 5 - 7, 1990, WASHINGTON, IEEE. COMP. SOC. PRESS, US, vol. SYMP. 11, 5 December 1990 (1990-12-05), pages 11-20, XP010022032 ISBN: 0-8186-2112-5 the whole document</p> <p style="text-align: center;">----- -/--</p>	1-7



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 2002/112097 A1 (MILOVANOVIC RAJKO ET AL) 15 August 2002 (2002-08-15)  abstract  paragraphs '0031! - '0069!  paragraphs '0087! - '0107!  paragraphs '0125! - '0134!  paragraph '0160!  figures 2a,3</p>	1,7
A	<p>LEATHRUM J F ET AL: "Modelling heterogeneous processor scheduling for real-time systems"  ROBOTICS AND COMPUTER INTEGRATED MANUFACTURING, ELSEVIER SCIENCE PUBLISHERS BV., BARKING, GB,  vol. 11, no. 2, June 1994 (1994-06), pages 91-98, XP004011780  ISSN: 0736-5845  page 91, right-hand column, line 32 - page 92, right-hand column, line 49  page 93, right-hand column, line 1 - line 19</p>	3
A	<p>KOROUSIC-SELJAK B: "TASK SCHEDULING POLICIES FOR REAL-TIME SYSTEMS"  MICROPROCESSORS AND MICROSYSTEMS, IPC BUSINESS PRESS LTD. LONDON, GB,  vol. 18, no. 9,  1 November 1994 (1994-11-01), pages 501-511, XP000483414  ISSN: 0141-9331  the whole document</p>	1-7

# INTERNATIONAL SEARCH REPORT

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2002112097 A1	15-08-2002	EP 1229444 A1 JP 2002312331 A	07-08-2002 25-10-2002